

The snow cover at the close of January, 1918, was unusually large throughout the Maumee watershed, and moderately warm weather and frequent rains subsequent to February 7 resulted in intense thawing. The surface run-off was large, the streams responded rapidly with increased stages, and the ice cover diminished and disintegrated quickly. In the upper reaches of the Maumee the ice began to break up on the 11th, but in the lower sections of the valley disintegration did not begin until the 12th or 13th. Gorges formed quite generally at upstream points on February 11 or 12, and at places east of Fort Wayne on the 12th or 13th. The gorges began to break up, as a rule, on February 14, except in Maumee Bay, where the final break up did not occur until March 3.

There was no flooding due to gorges at points above Defiance, Ohio; but from Napoleon, Ohio, eastward to Toledo, Ohio, the lowlands along the Maumee were inundated. On February 14 the water from the Maumee backed up to 19.5 feet at Napoleon, or 7.5 feet higher than would have occurred under normal conditions. Gorged conditions at Toledo caused the river to be above dock line from February 15 to 18, the maximum stage being 8.5 feet above the normal.

Detailed statements regarding the various gorges follow:

Montpelier, Ohio, St. Joseph River.—The ice at Montpelier was about 25 inches thick; it began to break up on February 14, and by the morning of the 15th the ice had moved downstream; the channel was free of ice and no gorge formed.

Fort Wayne, Ind., St. Joseph River.—A gorge formed at Tennessee Avenue bridge during the night of February 12 and extended a considerable distance upstream; the ice was from 12 to 18 inches thick, and by the morning of February 13 the gorge had disappeared; no damage resulted.

Fort Wayne, Ind., St. Marys River.—During the night of February 11 the ice began to break up on the St. Marys River and a gorge formed at Clinton Street bridge. The jammed ice extended upstream to Swinney Park, a distance of more than a mile; the gorge broke up and moved out at 12:15 p. m. February 14. The ice ranged from 10 to 20 inches in thickness. There was no damage.

As far as can be ascertained the ice moved freely down stream between Fort Wayne and Defiance, Ohio.

Defiance, Ohio, Auglaize River.—Between February 13 and 15 several gorges formed in the Auglaize. The most important of the gorges formed above the power dam and extended about 1 mile upstream. This gorge moved out on the 15th.

Napoleon, Ohio, Maumee River.—During the night of February 12 the ice in the shallow waters around Dependence Dam and Florida broke up and began to move downstream, gorging about 2 miles west of Napoleon. About 9:30 a. m. of the 13th the ice began to move out at Napoleon and gorged at the islands $1\frac{1}{2}$ miles east of Napoleon. The gorge held until 2:30 p. m. of the 13th, when it started to move out; it then jammed at Texas, Ohio, the water backing up to Napoleon, where a stage of 19.5 feet was attained at 3 a. m. of the 14th. At 10 a. m. of the 14th the gorge broke up and moved down the river. The ice was very dense and ranged from 16 to 24 inches in thickness. Although the flood waters covered a considerable area in the vicinity of Napoleon, the damage sustained was slight, as precautions had been taken to remove movable property to a place of safety.

Mr. W. S. Currier, official in charge of the Weather Bureau office at Toledo, Ohio, has furnished the following statement regarding ice and gorged conditions there.

"Ice began to form here along the shores of Maumee River and Bay on December 6, and by the 9th the river and probably much of Maumee Bay were frozen over. By the 17th of December the river ice averaged 8 inches in thickness and was reported to be 10 to 12 inches on the bay, but on the 24th the river ice was partially broken, due to the movement of tugs, and it only ranged from 2 to 4 inches in thickness where it had not been broken. Maumee Bay ice was from 7 to 9 inches thick on the 24th, but it was covered with water. After December 24 the ice on Maumee River and Bay increased in thickness until about February 4, 1918, ranging from 9 to 12 inches on the river and bay on January 14, and from 12 to 16 inches on January 21, reaching a maximum on February 4 of 18 to 22 inches on the river and 24 inches or more on the bay.

"After February 7 there was a rather rapid decrease in the ice covering the river and a slower decrease on the bay, the range in thickness on the river being from 9 to 12 inches on February 12, and the break-up began on February 14, due to rains in the valley and the coming down of ice from above. The ice opposite and below the city did not move to any extent, except to gorge in places, for some time after the break-up, as the bay ice held firm and prevented such movement. Maumee Bay ice broke on March 2 and 3 and moved out, allowing the ice in the river which had not previously disintegrated to move out, and all the ice of consequence was gone by the afternoon of March 4.

"From the 15th to the 18th of February the water in the river was above the dock line, due to gorged ice, the extreme height being about 8.5 feet above normal, and some damage and much inconvenience resulted from the water on Water Street and the flooding of many cellars for several blocks from the river. By February 27 the packed ice had disintegrated to such an extent that there were many open

places and the river channel was partially open down to near the bay."—P. McDonough, Meteorologist in Charge.

Columbus, Ohio, river district.

Notwithstanding the large quantity of ice that necessarily formed in the rivers of Ohio during the abnormally cold weather of the winter of 1917-18, it all passed out without damage of consequence at any point. In fact it would seem hardly possible for the rivers to clear themselves of ice with less damage. The ice began to break up and to move on February 9 and by the 12th was practically all out; at least all danger was past. The ice varied in thickness from about 12 to 20 inches.—W. H. Alexander, Meteorologist in Charge.

Dayton, Ohio, river district.

The Miami River and its tributaries became frozen on December 9, 1917, and were not free of ice until February 14.

The ice began breaking in the upper portion of the Miami February 9, and at Dayton on the 10th; and from the 10th to the 13th numerous gorges and ice dams formed in the main river and in the Stillwater.

On the 10th and 11th small gorges formed at Sidney, Ohio, one at the county bridge just south of the city and the other at the Baltimore & Ohio Railway bridge. The ice in these did not exceed 3 or 4 feet, and it passed out without doing any material damage.

A small gorge formed at Piqua against the unbroken ice, accumulating to a thickness of about 4 feet. This broke and passed out the night of the 10th without causing any marked rise in the water and without doing any damage.

On the 13th an ice dam formed at Tadmire, causing the water to rise 1 foot above the flood stage. Some farm land in the vicinity was flooded, but no damage resulted.

In the evening of the 10th the ice began collecting at Fifth Street, Dayton, Ohio, against a temporary bridge in use since the 1913 flood. About 9:30 a. m. of the 11th this structure gave way and was completely destroyed. The damage was not great, however, as the new permanent bridge was completed and ready for traffic about two days later.

About 10 a. m. of the 11th a gorge formed against the unbroken ice below the Main Street bridge, on which the gage is located, and held till about 1 p. m. This caused a rise of over 2 feet at the gage, but the ice passed out without doing any damage.

About 11 a. m. of the 12th a gorge formed at the Baltimore & Ohio bridge just above this city, and carried away a temporary structure which was in use while repairs were being made and one pier of the bridge. All traffic over the bridge was stopped for three days.

Several ice dams formed at West Milton on the Stillwater, beginning the morning of the 11th. The most important one was on the 12th and 13th. The dam extended for more than half a mile up and down the river and its thickness was estimated at 6 to 10 feet. At 5 p. m. of the 12th the water rose to a height of 17 feet which is 5 feet above the flood stage.

The dam went out the night of the 12th and the river fell quickly to a stage several feet below flood stage.

A few farms were flooded, but the damage was slight.—R. F. Young, Meteorologist in Charge.

ATLANTIC DRAINAGE.

SUSQUEHANNA RIVER.

Harrisburg, Pa., river district.

Some of the small streams on the Susquehanna River system became frozen during the latter part of November and by December 10 the river and its tributaries were generally icebound. The weather continued cold until near the end of the first week in February. January, 1918, was the coldest January at Harrisburg since the station was established, the mean temperature for the month being 19.1° or 9.6° below the normal. The ice on the streams increased gradually, the thickness on the rivers and creeks ranging from about 18 to over 36 inches. On account of the continued cold little or no snow water found its way into the streams. The "January thaw" that many people talk so much about did not occur and the snow continued to increase in the watershed. On January 30 the average depth of snow in the vicinity of Harrisburg was 24 inches, probably the greatest amount on the ground at any time in the last 30 years or more. The streets were packed with ice and snow to a depth of 2 feet or more and many of the narrow streets were impassable. Snow was piled along the curbs to a depth of 3 to 6 feet.

High temperature on February 7 caused the snow to decrease rapidly in depth, and by the 11th some streams began to rise. Ice movements began on the Juniata and Chemung Rivers on the night of February 12, that from the Juniata gorging at the mouth of the river near Duncannon. This gorge, which was 10 to 15 feet high, damaged the piers of the bridge at Juniata, destroyed two or three buildings and damaged others. As a

result of this gorge traffic was suspended on the Juniata highway bridge which crosses the Juniata River near its mouth to Duncans Island, and also on the covered highway bridge at Clarks Ferry, which spans the Susquehanna from Duncans Island to the eastern shore. The Chemung ice broke at Corning about 3 a. m. of the 13th and moved slowly down the river, forming ice jams, which broke as the water accumulated behind them, re-formed and broke again. Frank Gray and two boys who were with him narrowly escaped drowning, being caught by the ice flood on the flats between Lowman and Wellsburg while driving a team. They were finally rescued by men in boats. The horses also were saved. This ice flood reached Towanda on the night of the 13th, the ice breaking there about 9 p. m. of that day and moving out on a stage of about 13 feet. It reached Wilkes-Barre on the night of the 14th, passing on a stage of about 18 feet. The flood water from the Juniata gradually lifted the ice in the Susquehanna River below Duncannon, the break at Harrisburg occurring at 3:15 a. m. of the 15th on a stage of about 11 feet. The ice from the Chemung River and the North Branch below Athens reached the main river early on the morning of the 16th and began to pass Harrisburg about 3 p. m. of that date, the river reaching a maximum stage of 15.2 feet at 6 p. m. This flood lifted the gorge at the mouth of the Juniata and all the ice from the Juniata, Chemung, and the North Branch, together with most of that in the main river below Sunbury, lodged at Pequea, a short distance below the mouth of Conestoga Creek, about 55 miles below Harrisburg, forming a great gorge said to have been 20 or more feet in thickness and several miles long. This gorge caused serious flooding at Safe Harbor and vicinity, the railroad tracks there being several feet under water and ice for three or four days.

The ice in the West Branch broke at Clearfield at 1 p. m. on February 13, the river there reaching a maximum stage of 9.4 feet, slightly above flood point. At Renovo the break occurred about 4:30 p. m. of the 13th. The ice continued to move slowly, piling up and breaking and finally lodging, jamming the channel from Jersey Shore almost to Lock Haven with a gorge said to range in thickness from 10 to about 20 feet. Following a short period of warm weather with rain on the 19th and 20th, the water rose behind the gorge at Jersey Shore, causing serious flooding at points above, particularly at Lock Haven, where the water reached a stage of about 21 feet, flooding the railroad tracks to a depth of several feet and causing the suspension of all trains on the Northern Central and New York Central Railroads. The water covered most of the town to a depth of several feet. Some houses in the lower part of the city had water almost to the second floor. A cold wave with zero temperature on the night of the 20th caused the water in the houses to freeze to a thickness sufficient to permit people to skate on it. The light plant was flooded, and the people were without light and in many cases without fuel. The mayor of Lock Haven appealed for help, which was speedily furnished, but much suffering and some sickness resulted and the damage to property was great. The lower part of the Jersey Shore gorge broke on the night of February 20, passing Williamsport on a stage of 21.4 feet, 1.4 feet above the flood point. This break did not immediately relieve the serious situation at Lock Haven, as the upper part of the gorge held until about 3:30 p. m. of the 21st. During the 15 minutes following this break the water fell 4 feet on the Lock Haven gage. The ice from the West Branch began to pass Harrisburg during the afternoon of the 21st, the river reaching a maximum stage of 14.1 feet at 3 a. m. of the 22d and remaining stationary until afternoon, when it began to fall slowly. This flood opened a channel on the west side of the river at Pequea, and the river there fell rapidly on the 22d. Probably many small gorges or jams formed of which no information was received. The greatest damage to property occurred behind the Jersey Shore gorge, principally at Lock Haven, where it probably amounted to \$100,000. Many highway bridges were damaged and a few were destroyed, and some railway bridges were damaged. The Pennsylvania Railroad bridge crossing Conestoga Creek near Pequea sank about 2 feet while a freight train was crossing it soon after the gorge broke.

An accurate estimate of the damage caused by ice floods is impossible, but it is believed it is conservative to say that the loss in the Susquehanna watershed was at least \$300,000.

Considering the great accumulation of snow and the thickness of ice on the streams the damage was much less than might have been reasonably expected under the circumstances. A general and heavy rain over the watershed with high temperatures would have caused a disastrous flood. Actually but few places suffered, and the waters reached flood stage only over comparatively short stretches.—*E. R. Demain, Meteorologist in Charge.*

DELAWARE AND SCHUYLKILL RIVERS.

Philadelphia, Pa., river district.

Early in February, 1918, there was a snow covering of about 30 inches over the headwaters of all of the streams. The snow was solid and held a large water content, being the accumulations of the December and January snows.

It so happened that the snow melted a little at a time in three or four periods, and without rains of consequence: so that the ice, which was the heaviest in many years, broke up and passed out with comparatively little obstruction and with no material damage. Jams were reported in the Lehigh River at the Parryville dam and at Treichler's, but neither was of a serious character. A large amount of ice backed up in the Schuylkill at Philadelphia, but passed out on a sudden rise and without damage. The East Branch of the Delaware at Fishs Eddy, N. Y., rose to 16 feet on the 20th (the flood stage being 10 feet), but the water and the ice passed out with only slight damage. At Hale Eddy, N. Y., on the West Branch of the Delaware, the water rose to 13.4 feet on the 20th (flood stage being 12 feet). These waters seemed to spread out farther down the river, and at Port Jervis the highest stage was 9 feet (flood stage being 18 feet), while at Phillipsburg (junction of the Delaware and Lehigh) there was a stage of 15 feet on the 21st, or 7 feet below the flood stage.

The Schuylkill rose high enough at Manyunk, Philadelphia, on the 21st to temporarily suspend operations in several mills. Warnings were given to the police department on the 20th and movable property was taken care of. These were the only warnings issued and were the only ones practicable.—*George S. Bliss, Meteorologist in Charge.*

POTOMAC RIVER.

A short spell of mild temperature with light rain on February 10 melted much of the snow in the watershed above Washington, D. C. Mild temperature on the 11th and 12th, without rain, caused a break-up in the ice on the 12th from Cumberland, Md., to below Harpers Ferry, W. Va.

Washington, D. C.

February 13, 1918.—Ice broke up at 2:00 a. m. and a gorge formed from Chain Bridge nearly to the Aqueduct Bridge, gorged from Rock Creek to Highway Bridge; water 6 feet above bank at Chain Bridge and ice left 6 feet deep from river to canal bank. Gorges broke in places during the day and reformed at night. A firm gorge formed against Aqueduct Bridge during the night of February 13-14 and extended to Highway Bridge on the District of Columbia side. The old channel on the Virginia side of Anacostan Island cleared about 5.00 a. m. and allowed the flow of the river to go by that channel. Before the old channel on the Virginia side cleared, the ice was piled up 3 to 4 feet above the river wall at the gage, Twenty-seventh and G Streets, and would probably have gone 5 feet higher if the Virginia channel had not cleared. The water was 3.5 feet deep on K Street and Thirty-first Street, but stores were not flooded below Eighth and Pennsylvania Avenue.

February 16, 1918.—Some small gorges still held between Chain Bridge and Aqueduct Bridge.

February 18, 1918.—Channel on District of Columbia side cleared from Aqueduct Bridge to Highway Bridge. All house boats on the river were crushed by the ice and all boat houses, except three, were practically destroyed. Many dredges were carried down the river, but most of these were recovered later.

Loss to house-boats estimated at \$1,500.

Loss to boathouses estimated at \$15,000.

Loss to barges, stores, and business houses on K Street estimated at \$38,200.—*A. J. Henry, Meteorologist in Charge.*

JAMES RIVER.

Richmond, Va., river district.

The winter of 1917-18 to date has been unusually severe. Temperatures low enough to form ice on the various rivers of the State, were general in the latter part of November and from that time on until early in February, they continued low. In the river district under the supervision of this office (James River) the ice steadily increased in thickness during December, 1917, the coldest month of that name of record in this State, and also through January, 1918, and it was not until January 26, 1918, that the day temperatures became high enough to cause melting of the ice.

On this date, also, a six-day period of precipitation, which came partly as rain and partly as snow or sleet, set in. Fortunately, however, the night temperatures during this period were at freezing, or below, and this checked the run-off and prevented any sudden rise in the river and breaking up and gorging of the ice. From the close of January to February 6 freezing weather kept the ice intact, but on the last-named date the day temperatures rose and a general and decided thaw set in, checked as before by cool nights. The snow cover in the watershed, which was practically continuous from the middle of December until this time, and unusually heavy, disappeared rapidly and the resulting run-off soon reached the James, lifting the ice and starting it downstream. The situation thus became full of danger and was a source of anxiety to this office, and the people of the cities and